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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/708,978	04/05/2004	Laura Brown	FIS920030370	2977
23389	7590	04/06/2006	EXAMINER	
SCULLY SCOTT MURPHY & PRESSER, PC 400 GARDEN CITY PLAZA SUITE 300 GARDEN CITY, NY 11530			SUCH, MATTHEW W	
			ART UNIT	PAPER NUMBER
			2891	

DATE MAILED: 04/06/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.		Applicant(s)	
	10/708,978		BROWN ET AL.	
	Examiner		Art Unit	
	Matthew W. Such		2891	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 20 March 2006.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-30 is/are pending in the application.
- 4a) Of the above claim(s) 16,21 and 22 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-15,17-20 and 23-30 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 06 May 2004 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
 Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
 Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|---|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

2. Claims 1-30 are rejected under 35 U.S.C. 102(e) as being anticipated by Zhang ('884).

3. Regarding claims 1, 23 and 29, Zhang teaches a product and method of making the device with an interconnect structure by depositing a titanium layer on an interconnect having one or more contact openings which expose one or more silicide regions (Paragraphs 0033-0036).

An in-situ plasma nitridation process is subjected on the titanium layer (Paragraphs 0020-0029 and 0035-0036). A titanium-deposited layer which has been subjected to an in-situ gas plasma nitridation process is, by applicant's definition, a low thermal budget middle of the line (MOL) liner.

An additional deposition of at least one layer of titanium nitride by CVD follows the in-situ plasma nitridization step (Paragraphs 0038-0040; Fig. 1). CVD is performed by thermal decomposition of a titanium precursor and a nitrogen precursor (Paragraphs 0012-0013 and 0038; Applicant describes CVD has a process for thermal decomposition in Paragraph 0036).

The contact opening is then filled with a deposition of tungsten (Paragraphs 0044).

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4. Regarding claims 2, 5 and 24, Zhang teaches that a silicide can be a titanium silicide (Paragraphs 0006, 0013 and 0036).
5. Regarding claim 7, Zhang discloses that a titanium layer is typically deposited by physical vapor deposition (Paragraph 0007).
6. Regarding claims 8 and 27, Zhang teaches a titanium layer can be 100 Angstroms (Paragraphs 0011, 0013 and 0035).
7. Regarding claims 13-15, Zhang teaches that a plasma nitridization process can be 5-60 seconds (Paragraph 0035).
8. Regarding claim 17, Zhang teaches that a titanium precursor is titanium tetrachloride (Paragraph 0038).
9. Regarding claim 18, Zhang teaches that a nitrogen precursor is ammonia (Paragraph 0038).
10. Regarding claims 19 and 28, Zhang teaches that a titanium nitride layer deposited on a plasma treated titanium layer is less than 300 Angstroms (Paragraphs 0040 and 0042).

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11. Regarding claim 20, Zhang teaches that a plurality of titanium nitride layers can be repeatedly deposited (Paragraph 0041). For example, a first titanium nitride layer is formed by CVD on a plasma treated titanium layer (Paragraph 0038) followed by a second titanium nitride layer (Paragraph 0041).

12. Regarding claim 30, Zhang describes that tungsten contacts can be formed in the CVD chamber by a reaction of tungsten hexafluoride and hydrogen (Paragraphs 0022-0029 and 0044).

Claim Rejections - 35 USC § 103

13. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

14. Claims 3-4, 6 and 25-26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhang ('884) in view of Koo ('003).

15. Regarding claims 3-4 and 25-26, Zhang teaches the use of titanium silicide in an interconnect but does not disclose using cobalt silicide or nickel silicide.

Koo teaches a method of forming titanium nitride layers in interconnects with titanium silicide, cobalt silicide and nickel silicide in the interconnect (Paragraphs 0005, 0013, 0056 and 0061).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to use either cobalt silicide or nickel silicide regions in place of titanium

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silicide in an interconnect structure because Koo teaches silicides of Ti, Ni and Co were known functional equivalents.

16. Regarding claim 6, Zhang teaches the method of claim 1, forming a titanium nitride interconnect diffusion barrier with a plasma nitridization process. Zhang does not disclose cleaning the silicon substrate prior to titanium deposition since preconditioning of substrates and deposition chambers by cleaning are each conventional.

Koo also teaches a process to form titanium nitride interconnect diffusion barriers and further teaches a surface cleaning step before a titanium layer is deposited in the contact (Paragraphs 0016, 0018 and 0046-0060).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to use a cleaning process as described by Koo in the method of Zhang to remove any native oxide layer and impurities on the surface portion of the substrate (Zhang Paragraph 0060).

17. Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over Zhang ('884) in view of Miyamoto ('021).

Zhang teaches that plasma nitridization treatment of a titanium layer of a thickness of 100 Angstroms or less (several nanometers) with nitrogen and hydrogen gases results in the formation of titanium nitride (Paragraphs 0035-0036). Zhang is silent on whether all of the titanium is converted to titanium nitride.

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Miyamoto a method of forming titanium nitride interconnect diffusion barrier where all free titanium is converted to titanium nitride (Col. 7, Lines 19-20) during an in-situ plasma process in a nitrogen and hydrogen gas environment (Col. 3, Lines 14-18; Col. 17, Lines 21-38).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to convert all titanium to titanium nitride since Miyamoto teaches that a titanium film several nanometers in thickness completely converts to titanium nitride (Miyamoto Col. 7, Lines 19-20). One would be further motivated to convert all titanium to titanium nitride to avoid the potential reaction of fluorine with free titanium metal in the interconnect (Miyamoto Col. 3, Lines 60-67). Reaction of titanium with fluoride during a tungsten contact deposition results in a mixture of titanium fluorides and tungsten which is weak in adhesive strength and may result in interconnect peeling (Miyamoto Col. 3, Lines 60-67).

18. Claims 10-12 rejected under 35 U.S.C. 103(a) as being unpatentable over Zhang ('884) in view of Foster ('511).

Zhang teaches that plasma nitridization treatment of a titanium layer is conducted at a substrate temperature of 450-680 Celsius using ammonia (Paragraphs 0035-0036).

Foster teaches a method of plasma nitridation with ammonia of titanium layers on interconnect structures with a processing temperature from 300-650 Celsius (Col. 3, Lines 24-27, 32-33 and 49-53).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to use a low plasma nitridization processing temperature of, for example 350 Celsius, in order to reduce spurious source/drain dopant implant diffusion and maintain the electrical

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characteristics of the device (Foster Col. 1, Lines 25-31). It has been held that where the general conditions of a claim are disclosed in prior art, discovering the optimum or working ranges involves only routine skill in the art. In re Aller, 105 USPQ 233.

Response to Arguments

19. Applicant's arguments with respect to claims 1-30 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

20. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure:

Lee ('027), Wang ('297), Chang ('479), Chen ('826), Fukuzumi ('864), Harada ('420) and Chou ('021) each teach various methods for forming nitrided titanium diffusion barrier layers in interconnects by CVD and plasma processes.

21. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period

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will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

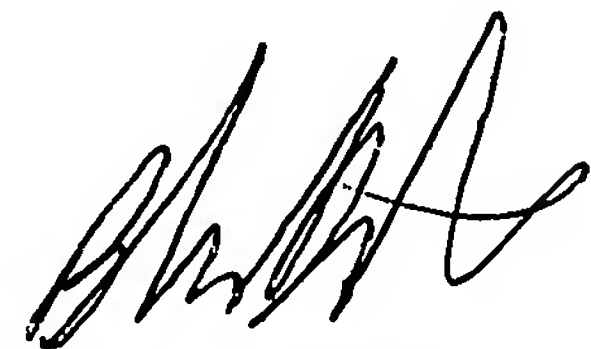
Contact Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew W. Such whose telephone number is 571-272-8895. The examiner can normally be reached on Monday - Friday 8AM-5PM EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Bradley W. Baumeister can be reached on 571-272-1722. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Matthew W. Such
Examiner
Art Unit 2891



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MWS
3/31/06